

**Title: Oh Snap!****Brief Overview:**

Students will collect, organize and analyze data using fractions, decimals and percents to make predictions about populations. They will then make estimates of the total number in a population based on sample data. They will use a capture/recapture technique and ratios/proportion to determine their estimates of the number of turtles in a pond.

**NCTM Content Standard/National Science Education Standard:**

Standard 1: Understand ways of representing numbers.

Standard 2: Represent and analyze situations using algebraic symbols.

Standard 4: Understand the units of measurement

Standard 5: Collect, organize, and display data; select and use proper statistical methods to analyze data; develop inferences that are based on data

Standard 6: Solve problems in math and other contexts

Standard 8: Use the language of math to express ideas; Communicate thinking clearly to others.

**Grade/Level:**

Grades 6 – 8 Middle School

**Duration/Length:**

Three 60 – 90 minute lessons

**Student Outcomes:**

Students will:

- collect, organize and analyze data by selecting and using proper statistical methods
- review and extend calculating mean in a set of data
- convert fractions, decimals and percents
- determine and use ratios and proportions to solve a real world problem
- make and check estimates
- communicate their thinking clearly to others

## **Materials and Resources:**

- A container of beans, packing peanuts, or any other item that could represent turtles
- Small scoop
- Permanent markers
- Calculators (optional)
- Worksheets
  - What Are You Afraid Of? (Homework prior to Lesson 1)
  - Fractions, Decimals & Percents-Part 1 (Warm-up Lesson 1)
  - Reba's Reptiles (Classwork Lesson 1)
  - Oh Snap! (Homework Lesson 1)
  - Surveying Pine Trees (Reteach/Extension Lesson 1)
  - Fractions, Decimals & Percents-Part 2 (Warm-up Lesson 2)
  - Capture Recapture (Activity Sheet Lesson 2)
  - School Surveys (Reteach/Extension Lesson 2)
  - Survey Says! (Pre-Assessment/Launch Lesson 3)
  - Summative Assessments

## **Development/Procedures:**

### **Lesson 1**

**Preassessment** – At the primary level, students have calculated mean for a set of 8 data points. This lesson will extend that to 10 data points. Students will use their prior knowledge of fractions, decimals, and percents. The lesson will extend one denominator beyond 100 in order to present an enrichment and class discussion. Assign Warm-up (Fractions, Decimals & Percents – Part 1) in order to review and assess students understanding of these concepts. Have students present their solutions.

**Launch** – Ask students this question. “Have you ever wondered how scientists are able to estimate the number of fish in a lake or the number of crabs in the Chesapeake Bay?” Discuss how they use population sampling to make estimates and to provide information about a certain species. Have students discuss what they feel constitutes a “fair” method of sampling populations, such as making sure the sampling is large enough and that they sample from all areas of the lake or the Bay.

**Teacher Facilitation** –This lesson objective is to identify populations and sampling methods. Students are

introduced to the concept that if you need information about a large group, or **population**, you can collect data about a small number of that group called a **sample**. The concept of a **random sample** where each population member has an equal chance of being selected should be introduced and discussed. There should also be a discussion about how sampling could be **biased**. Have students record their definitions of these terms in their notebooks. (Vocabulary words to be covered appear in **bold**.)

Student Application – In preparation for this lesson students were given a homework assignment in which they took a survey. See end of this CDU document for “What are you afraid of?” HW Assignment to be used PRIOR to Lesson 1. At this point in the lesson, students should be given time to discuss results of their survey within groups of 3-4 while the teacher checks for completed assignments.

Embedded Assessment – Students will complete the following problem in class individually and turn in their answers. Assign classwork “Reba’s Reptiles”

Review the following information and answer the questions: A recent survey of 200 people at the local mall found that more people in town own reptiles or birds than own traditional mammals, such as cats and dogs. The survey was conducted by Reba’s Reptiles, a store in the local mall that sells unusual pets.

Reptiles	20%
Birds	13%
Mammals	31%
Fish	8%

How much trust do you have in the survey? Do you think the conclusions are valid?

**ANSWER:** Do not trust the sample for several reasons; shoppers are all at the same mall; no information on how the sample was done to ensure equal representation or randomness; surveyor biased because of interest in unusual pets.

Reteaching/Extension –

- Reteach Problem: Surveying Pine Trees

(Classwork Lesson 1)

Scientists conducted a study to determine the average height of pine trees on Assateague Island. They did so by measuring 200 trees from the forest. Tell whether the following statements, if true, would lower your confidence in the results of the study. Explain your answers.

- a. The scientists chose the trees in their sample randomly.
- b. The scientists selected trees only from the western portion of the forest.
- c. Some of the trees measured in the study were much taller than others.
- d. The scientists measured only a small fraction of the total number of pine trees in the forest they studied.

**ANSWER:**

- a. No, a random sample should be representative.
- b. Yes, trees in one portion might either be genetically or environmentally influenced and therefore similar.
- c. Yes, if some trees were unusually tall they would make the average height taller than might be typical for the forest.
- d. No, this is the definition of a sample. A sample should be representative of the population if random and unbiased.

Extension Problem: (great for individual research):

Find the results of a survey in a newspaper, magazine, or online. Identify the population and the sampling method used and tell whether any of the questions asked are likely to be biased. How much confidence do you have in the results of the survey? Explain your answers.

**HOMEWORK:** Assign and explain the homework “Oh Snap!” Write your conclusions in complete sentences.

Lesson 2

Preassessment – See Warm-up Lesson 2 – Fractions, Decimals & Percents – Part 2

Launch - Students will continue the discussion of homework due on the day of Lesson 1 (“What Are You Afraid Of?”) in groups of 3-4 by comparing results and discussing the extension from their sample to the population. A whole class discussion should follow and should also include

Lesson 1 HW (Think About problem, “Oh, Snap” conclusions).

Another problem to introduce at the point is the following: If one student out of a class of 20 was absent, what percent of the class is absent? How many students out of a school of 1600 would you estimate to be absent based on this percent?

**ANSWER:** 5%; 80 students

Teacher Facilitation – The objective of this lesson is to make accurate conclusions/predictions about populations using sample and survey data. It will also include the extension to ratio and proportion as a tool.

Student Application – Performance Task (summative assessment) located at the end of this CDU.

Ask students, “Have you ever wondered how scientists are able to estimate how many fish are in a lake or how many birds migrate each year to Canada? A method they often use is called a capture/recapture technique. Scientists capture a sample of the population and tag them. They then come back and recapture more animals. They can then compare the ratios of captured (untagged animals) to recaptured (previously tagged animals). They use ratios and proportions to figure out approximately how many animals are in the total population from the samples. You are going to do a simulated model of the same kind of thing today only we will be using beans for “turtles” and tagging them with a magic marker. “

Review types of proportions and ratios. Ratios and proportions are comparisons of numbers. For example, the ratio of boys to girls in our group is \_\_\_\_ to \_\_\_\_\_. We can write it three ways. Point out some examples of ratios on the poster and discuss how they would be written. Also discuss if the ratios are part-to-part, part-to-whole, or whole-to-whole relationships.

1. Have a small bucket or of approximately three to five hundred beans or Styrofoam packing peanuts.
2. Students should come up and take a handful or small scoop of about 10 to 20 beans or peanuts.

3. They will record the number on the activity sheet.  
(Capture/Recapture)
4. They will then “tag” the beans or peanuts with a magic marker and return them to the bucket mixing them in.
5. Students will share their numbers to come up with a total number tagged and record.
6. Students will now take another sample and record the number of tagged (recaptured) to untagged (captured) beans. Each group should record their own data on the recording sheet. Have students come up and record their data on the board so it can be shared with the class. After students share their data have them determine the mean number of each.

How could we compare our sample ratios to the entire population? What do we know about ratios? Isn't the sample just a “smaller” representation? Kind of like an equivalent fraction is a fraction with smaller numbers. We can do the same thing here.

Have them set up the ratio comparing the sample ratio to the unknown ratio of tagged to total population as an equivalent fraction. Solve the equation and then allow students to count the actual number of beans.

**Extension:**

1. How close was our estimate?
2. What could we do to make the estimate more accurate?
3. Why was it helpful to have the entire class share their data?

**Evaluation:**

Propose a similar problem involving a different animal population, but give them the data.

Embedded Assessment – At this time, the teacher will circulate throughout the room checking to see if the sample data being collected and tabulated by the groups is in fact representative of the population. The teacher would have predetermined these numbers prior to the activity.

Reteach/Extension –

For a reteaching exercise, use “School Survey”  
(Reteach/Extension)

A school has 1000 students. A survey asks 375 students chosen at random to name their favorite color. Thirty say their favorite color is blue. Use the result to predict how many students at the school would say blue is their favorite color.

- a. Find the sample percent:  $30 / 375 = 0.08 = 8 \%$
- b. Find 8 % of (the total number of students) 1000:

$$8\% \times 1000 = 0.08 \times 1000 = 80 \text{ students}$$

**CHECKPOINT:**

In a survey of a random sample of 400 students at the school in the example above, 70 students said they prefer to exercise before school. Predict how many students at the school would prefer to exercise before school.

**ANSWER:** 175 students

For an extension, weights could be included on the “turtles” (beans/packing peanuts). Students would find the average weight of each turtle groups. Outliers could be included for a richer discussion.

**HOMEWORK:** Data from both the “What are you afraid of” and the “turtle pond” samples should be written as fractions, decimals, and percents.

Lesson 3

Preassessment/ Launch – See Warm-up for Lesson 3. “Survey Says!”

Teacher Facilitation – A great way to continue the activity from Lesson 2 would be to use the data from each group (pair) of students and find an overall mean sample size for each type of turtle and extend that to the overall population size. If weights were included, again, using group data, overall averages can be calculated as a class. Make sure each student is responsible recording calculations. A discussion of outliers is also appropriate.

Student Application – Today, our goal is to extend the use of proportions to this topic of sample being used to make assumptions and predictions for populations.

Example: Each day, an elephant eats 5 pounds of food for every 100 pounds of its body weight. How much does a 9300 pound elephant eat per day?

One way to solve proportions is with equivalent equations as follows:

$$5 / 6 = a / 18$$

If you compare the denominators of the above fractions you will find that  $6 \times 3 = 18$ , therefore,  $5 \times 3 = 15$  which leads us to the fact that  $a = 15$ .

Solve for the variable in the following proportions using equivalent fractions:

1..  $2 / 7 = b / 21$

2.  $3 / 8 = c / 32$

3.  $d / 2 = 20 / 10$

4.  $e / 48 = 6 / 12$

**ANSWERS:** 1.  $b = 6$ ; 2.  $c = 12$ ; 3.  $d = 4$ ; 4.  $e = 24$

Embedded Assessment – Give students a chance to solve the elephant example individually and then open it up for class discussion. **ANSWER:** A 9300 pound elephant eats about 465 pounds of food per day.

Another example: You know that 3 pizzas are enough to feed 12 people. Write and solve a proportion to find the number of pizzas that will feed 28 people.

**ANSWER:**  $3 / 12 = p / 28$ . It will take 7 pizzas.

Reteaching/Extension –

Reteach Problem: Consider the following

$$5 \text{ apples} / 8 \text{ oranges} = y \text{ apples} / 40 \text{ oranges}$$

This example can be restated (as in language arts class).

**Five apples is to eight oranges as “y” apples is to 40 oranges. How many apples will make this a true**

**statement? OR  $8 \times \text{five} = 40$  oranges therefore,  $5 \times \text{five} = 25$  apples.  $Y = 25$ .**

For an extension in this lesson, students should be asked to write their own word problem that would use ratio and proportion to solve.

**Summative Assessment:**

Students will complete a performance task, a Key List and a Best Answer assessment located at the end of the CDU.

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## What Are You Afraid Of?

Name: \_\_\_\_\_

### Homework

Everyone is afraid of *SOMETHING*! Your job is to conduct a survey to determine what *most* people are fearful of. By taking a random sample survey you can make conclusions about a larger population.



### Directions:

Survey 10 people to find out what they fear the most. Participants in the survey should choose from the following animals.

- Snakes
- Insects
- Lizards
- Snapping turtles
- Bats
- Other

### Conducting the Survey

1. Design a survey question which is straightforward and non-biased?

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2. Why do you think you should include the category of “other” in your survey?

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3. Design your survey so that your sample is a simple random sample. Explain how you know your results will be a true simple random sample.

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4. What populations will be represented?

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5. Conduct your survey. Record your results in the table below.


Fractions  $\leftrightarrow$  Decimals  $\leftrightarrow$  Percents  
Warm-Up

Write the following fractions as decimals and percents.

1.  $\frac{3}{20}$

2.  $\frac{5}{4}$

3.  $\frac{1}{500}$

4. A waterman caught 10 rockfish while fishing in the Chesapeake Bay. The weight in pounds of each fish is listed below. Determine the mean weight of the fish he caught.

12    15    8    16    12    11    12    13    10    11

Write the following fractions as decimals and percents.

1.  $\frac{3}{20} = 0.15 = 15\%$       2.  $\frac{5}{4} = 1.25 = 125\%$       3.  $\frac{1}{500} = 0.002 = 0.2\%$

4. A waterman caught 10 rockfish while fishing in the Chesapeake Bay. The weight in pounds of each fish is listed below. Determine the mean weight of the fish he caught.

12    15    8    16    12    11    12    13    10    11

16 pounds

## Oh, Snap!

Name: \_\_\_\_\_

Two scientists from the Department of Natural Resources are trying to gather information in order to find the average weight of snapping turtles in Maryland. They each have different methods on how to gather the data.



Scientist #1: The first scientist gathers large samples of turtles from one pond.

Scientist #2: The second scientist weighs a smaller number of turtles from several ponds.

- Which scientist will have a more accurate estimate of the average weight of the snapping turtles? Use mathematics to explain your answer. Use words, symbols, or both in your explanation.

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A recent survey of 200 people at the local mall found that more people in town own reptiles or birds than traditional mammals, such as cats and dogs. The survey was conducted by Reba's Reptiles, a store in the local mall that sells unusual pets.

**Reptiles****20%****Birds****13%****Mammals****31%****Fish****8%**

- How valid and reliable are the results of this survey? Use what you know about surveys to justify your answer. Use words, symbols, or both in your justification.

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A recent survey of 200 people at the local mall found that more people in town own reptiles or birds than traditional mammals, such as cats and dogs. The survey was conducted by Reba's Reptiles, a store in the local mall that sells unusual pets.

	Reptiles	20%
	Birds	13%
	Mammals	31%
	Fish	8%

- How valid and reliable are the results of this survey? Use what you know about surveys to justify your answer. Use words, symbols, or both in your justification.

Do not trust the sample for several reasons.

- The shoppers surveyed are all at the same mall
- No information on how the sample was done was provided to ensure equal representation or randomness.
- Surveyor biased because of interest in unusual pets.

## Surveying Pine Trees

Name: \_\_\_\_\_



Scientists conducted a study to determine the average height of pine trees on Assateague Island. They did so by measuring 200 trees from the forest.

Tell whether the following statements, if true, would lower your confidence in the results of the study. Explain your answers.

- The scientists chose the trees in their sample randomly.

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- The scientists selected trees only from the western portion of the forest.

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- Some of the trees measured in the study were much taller than others.

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- The scientists measured only a small fraction of the total number of pine trees in the forest they studied.

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## Surveying Pine Trees

Name: \_\_ANSWER KEY\_\_



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Tell whether the following statements, if true, would lower your confidence in the results of the study. Explain your answers.

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No, a random sample should be representative.

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- The scientists selected trees only from the western portion of the forest.

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Yes, trees in one portion might either be genetically or environmentally influenced and therefore similar.

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Yes, if some trees were unusually tall they would make the average height taller than might be typical for the forest.

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- The scientists measured only a small fraction of the total number of pine trees in the forest they studied.

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No, this is the definition of a sample. A sample should be representative of the population if random and unbiased.

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Fractions  $\leftrightarrow$  Decimals  $\leftrightarrow$  Percents Part 2  
Warm-Up

Write the following fractions as decimals and percents.

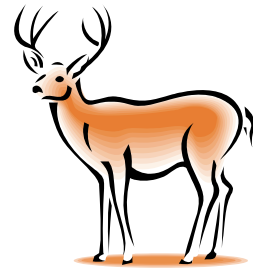
1.  $\frac{46}{100}$

2.  $\frac{32}{200}$

3.  $\frac{45}{500}$

4.  $\frac{35}{700}$

5. A forest ranger kept track of the number of white-tail deer spotted in a certain section of the park each day. He collected data for one week. Determine the mean number of deer sightings.



14 18 13 32 15 15 17

Write the following fractions as decimals and percents.

1.  $\frac{46}{100}$

0.46  
46%

2.  $\frac{32}{200}$

0.16  
16%

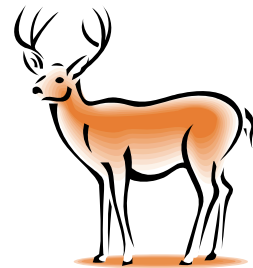
3.  $\frac{45}{500}$

0.09  
9%

4.  $\frac{35}{700}$

0.05  
5%

5. A forest ranger kept track of the number of white-tail deer spotted in a certain section of the park each day. He collected data for one week. Determine the mean number of deer sightings.



14 18 13 32 15 15 17

17.714 (rounded to 18)

Name: \_\_\_\_\_

Date: \_\_\_\_\_

## Capture/Recapture

Have you ever wondered how scientists are able to estimate the number of fish in a lake or the number of tigers left in the wild?

One method often used is a capture-recapture technique.

We will use proportions to estimate the number of "turtles" in our "river".

1. Take a scoop of beans from the bucket and record the number below.

\_\_\_\_\_ My sample

\_\_\_\_\_ Total samples

2. Now mark each of these beans with the marker and return them to the bucket. Scientists assume that these "tagged" turtles will mix uniformly with the rest of the population, so be sure to mix them back together well.

3. Record 5 scoops of beans taken back out of the bucket and record the number of captured and recaptured (tagged) turtles in the first column below. You will use the other columns to record your classmate's totals from the board.

Recaptured (tagged)															
Captured (untagged)															

4. Find the class' total number of captured (tagged) and recaptured (untagged) "turtles" and record below.

Recaptured \_\_\_\_\_

Captured \_\_\_\_\_

5. What is the average or mean number of Recaptured and Captured?

Recaptured \_\_\_\_\_

Captured \_\_\_\_\_

6. Now we will use what we know about ratios to estimate the number of turtles in the lake by setting up an equation.

\_\_\_\_\_ = \_\_\_\_\_

7. What is the estimated number of turtles in our river? \_\_\_\_\_

8. What is the actual number of turtles? \_\_\_\_\_

Explain how you determined your answer.

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## School Surveys

Name: \_\_\_\_\_

Complete each exercise.

1. A school has 1000 students. A survey asks 375 students chosen at random to name their favorite color. Thirty say their favorite color is blue. Use the result to predict how many students at the school would say blue is their favorite color.
2. In a survey of a random sample of 400 students at the school in the example above, 70 students said they prefer to exercise before school. Predict how many students at the school would prefer to exercise before school.



## School Surveys

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## School Surveys

Name: \_\_ANSWER KEY\_\_



Complete each exercise.

1. A school has 1000 students. A survey asks 375 students chosen at random to name their favorite color. Thirty say their favorite color is blue. Use the result to predict how many students at the school would say blue is their favorite color.

$$\frac{30}{375} = 0.08 = 8\%$$

$$0.08 \times 1000 = 80 \text{ students}$$

2. In a survey of a random sample of 400 students at the school in the example above, 70 students said they prefer to exercise before school. Predict how many students at the school would prefer to exercise before school.

175 students

**Survey Says!**  
**Warm Up**

Name: \_\_\_\_\_

1. A school has 800 students. A survey of a random sample of 80 students finds that 48 students enjoy swimming. Predict the total number of students in the school who enjoy swimming.  
  
**A.** 48                      **B.** 384                      **C.** 480                      **D.** 3840
  
2. In a random survey, it is found that 75 out of 200 households in the state of Maryland have a boat.
  - Predict how many households in the entire population of 135,000 would have a boat.
  
  - How would this data change if the survey were taken in a state in the mid-west?

**Survey Says!**  
**Warm Up**

Name: \_\_\_\_\_

1. A school has 800 students. A survey of a random sample of 80 students finds that 48 students enjoy swimming. Predict the total number of students in the school who enjoy swimming.  
  
**A.** 48                      **B.** 384                      **C.** 480                      **D.** 3840
  
2. In a random survey, it is found that 75 out of 200 households in the state of Maryland have a boat.
  - Predict how many households in the entire population of 135,000 would have a boat.
  
  - How would this data change if the survey were taken in a state in the mid-west?

**Survey Says!**  
**Warm Up**

Name: \_\_ANSWER KEY\_\_

1. A school has 800 students. A survey of a random sample of 80 students finds that 48 students enjoy swimming. Predict the total number of students in the school who enjoy swimming.

A. 48

B. 384

C. 480

D. 3840

2. In a random survey, it is found that 75 out of 200 households in the state of Maryland have a boat.

- Predict how many households in the entire population of 135,000 would have a boat.

50,625

- How would this data change if the survey were taken in a state in the mid-west?

Since the State of Maryland has a large bay and numerous rivers it is expected that there would be many boats. There are few waterways in the mid-west so the number of boats owned would drop drastically.

## **Performance Task: Ratios**

### **Lesson 2**

#### ***Background:***

The Department of Natural Resources is studying the effects of the building of a new housing development on the banks of a creek in Maryland. In particular, they are concerned about the turtle population.

#### ***Task:***

As a research scientist, you are asked to estimate the number of turtles in the creek. The DNR will collect this data and use it to compare the population numbers from year to year. You will use a capture/re-capture technique and analyze the ratios of your samples to make this estimate.

#### ***Audience:***

Your boss at the Department of Natural Resources

#### ***Purpose:***

The purpose of your task is to:

1. Show that you know how to collect, record and organize data accurately.
2. Demonstrate your knowledge of ratios to estimate the total population based on the sample data.

Procedures:

1. Collect and record sample data in an organized way.
2. Use the sample data to estimate the total population with ratios.

## Key List

Identify the following comparisons as a ratio that represents:

<b>P/P</b>	<i>Part-to-Part</i>
<b>P/W</b>	<i>Part-to-Whole</i>
<b>W/W</b>	<i>Whole-to-Whole</i>

\_\_\_\_\_ 1. The number of boys in a classroom vs. the number of students in the classroom

\_\_\_\_\_ 2. The amount of sugar mixed with water to make hummingbird food

\_\_\_\_\_ 3. The number of snapping turtles in a pond vs. the total number of turtles in the pond

\_\_\_\_\_ 4. The number of goldfish in a tank vs. the number of tetras

\_\_\_\_\_ 5. The amount of oil mixed with gasoline to power a 2-cycle mower

## Best Answer

Which set of directions *best describes* how to find a good estimate of the population of fish in a pond?

\_\_\_\_\_A.

1. Capture and tag several samples throughout the pond.
2. Recapture and count the number of tagged fish.
3. Determine the ratio of the number of tagged fish to the number from the first sample.
4. Calculate the estimate using this ratio.

\_\_\_\_\_B.

1. Capture and tag several samples throughout the pond.
2. Recapture and count the number of untagged fish.
3. Determine the ratio of the number of untagged fish to the number from the first sample.
4. Calculate the estimate using this ratio.

\_\_\_\_\_C.

1. Capture and tag several samples throughout the pond.
2. Recapture and count the number of tagged and untagged fish.
3. Determine the ratio of the number of tagged fish to untagged fish.
4. Calculate the estimate using this ratio.